Colorado's Vision:

RoadX

Where Transportation and Technology Intersect

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WHAT IS ROADX?

RoadX is Colorado's bold vision and commitment to being a national leader in the use of innovative technology to improve the safety, mobility and efficiency of the transportation system, fostering the continued economic vitality of our state.

It is a rapid, fast-paced venture that will enable the Colorado Department of Transportation (CDOT) to build the roadways of tomorrow – today. RoadX will create an environment where industry has a direct connection with a state that is committed to deploying comprehensive technological solutions to transform an aging transportation system.

RoadX Vision:

Crash-free, injury-free, delay-free and technologically-transformed travel in Colorado.

RoadX Mission:

Team with public and industry partners to make Colorado one of the most technologically advanced transportation systems in the nation, and a leader in safety and reliability.

WHY IS NOW THE TIME FOR ROADX?

History has vividly illustrated that humanity thrives when it has the ability to travel unobstructed. In the 20th century, man achieved unequaled leaps in travel around the world and even to the moon. Nationally and especially in Colorado, over the last 100 years, we have seen incredible leaps in progress and economic vitality when we have invested in our transportation system.

In the late 1800s, a group of businessmen formed the Denver Chamber of Commerce with the express purpose to raise the funds necessary to ensure the railroad came to Colorado. This entrepreneurial mindset forever changed the landscape of Colorado.

In 1910, the first Colorado Transportation Commission was formed, conducting primary business via horseback. In less than 10 years, roads and motor vehicles were crisscrossing Colorado. The radical paradigm shift on what defined personal transportation was underway.

More recently, Coloradans embarked on two leaps of commitment and ingenuity. The first was moving Denver International Airport, transforming how we connected the world to Colorado. The second was voters approving FasTracks in 2004, the metro-wide light rail, commuter rail and bus rapid transit system that is reshaping our transportation landscape and changing how we choose to travel.

Today, we face several monumental challenges in our fundamental endeavor to make great achievements in transportation and mobility.

1 **Vision for the Future** — Our transportation system is based on "Model T" technology and the decades of long-term planning and building of our transportation system has developed into an environment and culture where innovation has declined.

2 **Safety & Reliability** — Though we enjoy more ease of travel than at any other time in history, traffic related deaths and serious injuries, and the resulting unreliability of the transportation system, tarnish our achievements as an industry.

3 **Economic Vitality** — Our state's economic vitality is directly tied to the capacity to move people, goods and information. Growth-caused congestion stifles that vitality and potential for future growth.

4 **Funding** — Our economic success is largely dependent upon the success of our transportation system, yet Colorado's approach to funding transportation hinders our ability to markedly improve our transportation system in the traditional fashion.

5 **Rapid Technological Advancement** — While manual control of a vehicle is still predominant in 2015, before a person born today reaches his 18th birthday – that will all change.

> **Although man reached the moon in the last century, our achievement in travel on the earth has slowed in this century. We have been trying to shape Colorado's 21st Century destiny with 20th Century transportation solutions.**

We are heirs to a system we don't have the resources to adequately maintain, rebuild or expand.

Today;

- Colorado ranks 32nd out of 50 states in the quality of our pavement.

- Our metro areas in Denver and Colorado Springs are some of the most congested cities in the country, metro Denver ranking 19th worst in congestion and 16th worst in trip reliability.

- Our populations grew by 50 percent in the last 20 years and will grow by another 50 percent in the next 20.

- In 2014, 488 people died in traffic related crashes using Colorado's transportation system and another 3,219 were seriously injured.

- In 2014, the cost of all crashes in Colorado was $13.27 billion, or approximately $2,500 per person.

- Congestion in Denver/Aurora costs $1,101 per commuter per year.

- Today's mobility solutions still reinforce the nation's dependence on imported sources of energy and impact greenhouse gas emissions.

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Historically, the approach to these challenges was to add more lanes to the system, an expensive proposition that has resulted in an $800 million a year funding gap and a legacy system that we do not have the funds to fully maintain. We have learned – we cannot just build our way out of congestion.

As shown with the advent and rapid adoption of the personal computer, the Internet and smart devices – technological deployment dramatically changes how we do business, impact our environment, live our lives and spend our time.

Transportation and mobility have yet to fully benefit from these advancements.
The Colorado Department of Transportation (CDOT) is convinced that the integration of technology is the next logical step. And, while we know that a new technological focus in transportation does not guarantee Colorado will achieve all of its strategic goals; we know that a failure to do so guarantees we will not achieve any.

RoadX is Colorado's commitment to being a national leader in the rapid and aggressive implementation of innovative technology to revolutionize the safety, mobility and efficiency of our transportation system within the next 10 years, and that commitment starts now.

> **CDOT understands that the integration of technology and transportation is the logical – and inevitable – next step.**

ROADX PUTS COLORADO IN THE DRIVER'S SEAT

Just as we made the radical shift in 1910 from horses to cars, the transportation industry is again at a crossroads. Over the next several years, virtually all of the major car manufacturers will offer vehicles to the public that can take over highway driving, manage traffic jams or protect someone from a crash. Many already offer features that let the car do the driving for periods of time on straight stretches of road. Other innovators are working on applications that can be applied to vehicles aftermarket to assist drivers. Self-driving cars have logged thousands of miles and Silicon Valley has entered the car market.

Self-driving cars are only one of the radical changes. We have entered an era where big data can be leveraged to assess real-time and historical roadway conditions and provide more efficient decision making for vehicles and drivers. New on-demand mobility companies in the new "sharing economy" are reshaping how people think about mobility, turning it into a real-time service to be used when needed. RoadX puts Colorado in the driver's seat to ensure our state benefits from significant advances, including:

Automated technologies like an autopilot feature are rapidly becoming more common and the race to deliver self-driving vehicles is well underway.

- Smart device applications to direct your mobility

- Connected vehicles and drivers that will have the capacity to "talk" to each other, helping to prevent accidents and improving the flow on the road

- Trucks linking through technology, creating on the road platoons that reduce the cost to get to market

- Automated features like virtual guardrails and infrastructure technology that speak to cars will help to eliminate crashes

These technologies are a reality. And yet, the speed of change in transportation technology will make even these advances seem like yesterday's, if we don't embrace and utlize them now.

COLORADO NEEDS ROADX NOW

We must address our infrastructure challenges with 21st century technology and ingenuity, instead of 20th century thinking. We must embrace the fact that bold actions must be part of the equation to drive ideas forward. We must relentlessly protect our environment, our quality of life and our safety while boosting our economic growth. We must create a nimble transportation and regulatory system capable of keeping pace with tomorrow's change. We must envision tomorrow – TODAY.

No single transportation undertaking in this decade is more important for the long-term economic strength of Colorado and for the quality of life of our residents than RoadX. Simply put, RoadX will revolutionize our transportation system.

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ROADX ACTION PLAN

WHO IS ROADX?

RoadX will be a collaborative enterprise focused on building partnerships, entrepreneurial relationships and delivering innovative solutions. CDOT is seeking to convene a RoadX InnoVisers Council, tapping innovators and advisors from within the state, across the nation and worldwide, as well as leaders from public and private industry, to guide the integration of technology into Colorado's transportation system.

COLORADO IS OPEN FOR BUSINESS – Bring us your expertise and solutions! We need industry to get involved in the identification of the best technological solutions.

HOW WILL ROADX BE FUNDED?

CDOT's annual budget is $1.4 billion dollars. Each year, we spend hundreds of millions of that budget to improve the safety and mobility of the traveling public. Recent developments in technology are bringing about opportunities to achieve the same goals through less capital construction and the deployment of more technology solutions.

CDOT is committing $20 million in funding over the next year to obtain congestion relief and safety improvements through the deployment of technology, to kick-start RoadX. CDOT is currently adjusting its policies so funding categories further align with the integration of technology in transportation and mobility. Each year, as we realize the full benefits of these projects, CDOT is committed to investing more in technology to obtain our goals of safely moving people and promoting Colorado's economy.

Example: The managed motorways project in Australia utilized ramp metering for all of its on and off ramps and used complex computer algorithms to control the access and exits on the highway.

The Goal: Maximize throughput on the interstate and maintain a constant flow of traffic.

The Result: An increase in traffic speeds of 35% to 60% during peak times.

ROADX 2016: INDUSTRY CALL TO ACTION

Why Work with Colorado?

We have the vision. You have the knowledge.

Our business proposition is simple: Increase investment in technology resulting in a superior return on the state's investment in funds, safety and mobility.
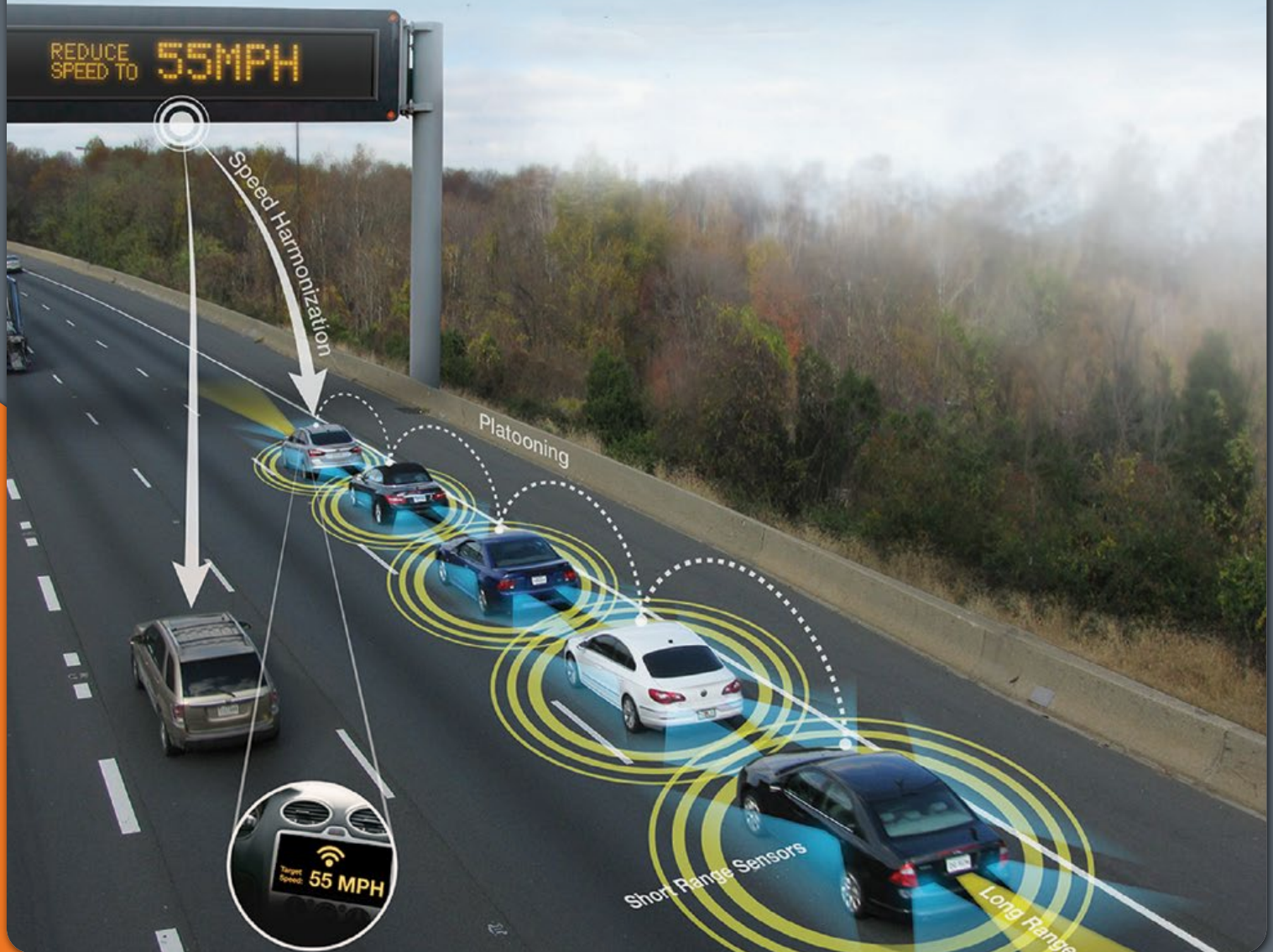
What We Offer:

Colorado's vision to transform our state's transportation system into one of the safest and most reliable in the nation by harnessing emerging technology begins with our commitment to:

- Providing industry access to key state assets for statewide transportation technology deployment partnerships

- Offering an industry-friendly technology partnering environment at all levels of public policy – state, regional and local

- Funding $20 million of foundational technology projects in June of 2016, with like amounts anticipated in future fiscal years

- Accelerating the re-allocation of CDOT's annual $1.4 billion budget from hard capital asset investment to invest in technological solutions as rapidly as industry can provide innovation that meets CDOT's transportation goals

What We Need:

While Colorado has the ability to fund and begin individual technology-related pilot projects, we recognize the importance of ensuring that 1) each project has industry input, and 2) these projects all provide an interconnected foundation that builds toward our ultimate vision – the transformation of our transportation system. We are looking for the technology industry to:

- Partner with Colorado to make RoadX come to life as soon as possible by identifying the organizational structure, regulatory and policy changes, funding needs, an accelerated schedule, etc., necessary for CDOT to establish an environment that will successfully attract private sector partners to help Colorado achieve its RoadX Capstone Project (Appendix A)

- Offer specific ideas for implementation of 2016 - 2017 Foundational RoadX Technology Projects (Appendix B)

- Identify the baseline requirements for successfully merging technology and transportation

Appendix A

RoadX Capstone Project #1 –
The RoadX Corridor

Capstone Project Vision: Crash-free, injury-free and delay-free travel by maximizing the efficient use of infrastructure.

Technology has the potential to dramatically influence innovative roadway utilization, such as narrowing lanes and shoulders to accommodate more travel lanes. While many believe this will take several decades to accomplish, CDOT aims to accelerate this process by partnering with industry – our lives and our economy depend on it.

In 2016, CDOT will begin to explore partnership opportunities to implement its first RoadX Corridor, to be explicitly used by vehicles with automated freeway driving capabilities. This will be accomplished through the conversion of an existing managed lane, building new lanes or converting shoulders.

The RoadX Corridor under this model could provide the following benefits:

- Reduce crashes

- Improved throughput and reliability

- Incentivize the use of automated vehicles and accelerate their market penetration

- Provide safety and mobility benefits on roads other than the RoadX Corridor

- Vividly showcase the potential of a highly technologically advanced vehicle fleet and transportation infrastructure to improve safety, reliability and efficiency

Other RoadX Capstone Projects could include:

- Reconfiguring freeway and/or arterial facilities to maximize efficiency of all travel and yield benefits of advanced technology vehicles

- Connected vehicle technologies

- Electric vehicle supporting technology

- Use of advanced data collection and analytics

- Demand management strategies

- Transportation systems management strategies

- Weather management technologies and strategies

CDOT commits to providing an environment where private industry innovation has the opportunity to grow commercially while providing benefits in transportation performance. The RoadX Capstone Projects are not focused on achieving slow and incremental benefits, but rather solutions that are comprehensive and holistic in their nature that work toward exponential improvements in the travel experience and performance of the system. CDOT's intent is not to prescribe solutions, but to foster the environment where partnerships can flourish, true innovation can occur and solutions can be rapidly deployed.

Short-Range Sensors

Long-Range Scanning Sensors

Short-Range Blind-Spot Sensors

Appendix B

2016 Action Plan: Foundational RoadX Technology Projects

CONNECTION: Transform Colorado into the most data-connected transportation system in the nation.

TRANSPORT: Transform Colorado into the safest and most efficient freight transport system in the nation.

COMMUTING: Transform Colorado into the most reliable transportation system for commuting in the nation.

SAFETY: Make a dramatic leap towards zero deaths on Colorado roadways.

INTEGRATION: Transform the state and its communities into the most technologically advanced in the nation by integrating a technology culture into all of our processes, workforce and systems.

This section outlines projects identified for 2016 - 2017 within each of these five action areas. Each is intended to improve the safety, mobility and/or efficiency of Colorado's transportation system and build toward the Capstone Projects.

We are looking to the technology industry to:

- Help identify the best technological solutions for each of the focus areas and/or specific 2016 - 2017 projects outlined in this appendix

- Analyze and determine how these focus areas and foundational projects should inter-relate to support the accelerated achievement of Colorado's Capstone Projects

- Suggest any alternate projects that should be considered for early exploration, testing or deployment, based on Colorado's Capstone Projects

CONNECTION

Description: Engage industry to develop solutions to transform data into actionable intelligence and deliver to drivers, cellular/mobile applications and connected and autonomous vehicles.

Project #1: Interoperable Data Platform: Deploy a web-based, open source safety, traffic and transportation system data platform capable of communicating with a diverse collection of drivers, cellular/mobile applications, and connected and autonomous vehicles to deliver critical real-time, actionable information and safety voice alerts such as multi-vehicle pileups, rock falls, avalanche slides, white-out/fog-out low visibility, wrong-way drivers, runaway trucks, stopped vehicles, incident advisory, icy roads, emergency vehicles, curve speed warnings, intersection hazards, work zone warnings, sun glare warnings.

Geographical Focus:	Timing:	$ Anticipated Investment:
Statewide	Industry engagement by Dec. 2015; Solicit industry solutions by Feb. 2016	$1 million

Project #2: I-70 Connected Vehicle Pilot Deployment: Maximize safety and mobility on the I-70 mountainous corridor through probe data collection, vehicle-to-infrastructure (V2I) communication, and related decision support analysis to enable real time traffic management and traveler information and safety applications.

Geographical Focus:	Timing:	$ Anticipated Investment:
I-70 (Vail-DIA)	Seeking input from industry by June 2016	$10 million

TRANSPORT

Description: Deploy emerging in-vehicle technology and supporting infrastructure to improve the safety and efficiency of transporting freight.

Project #1: Industry Focused Pilot: Partner with a key industry in Colorado, with the goal of reducing the cost of transporting goods, improving the bottom line and impact to local roads by outfitting selected commercial vehicle fleet vehicles with vehicle-to-vehicle and vehicle-to-infrastructure technologies and deploy supporting infrastructure and systems to support truck platooning, frontal collision avoidance, etc.

Geographical Focus:	Timing:	$ Anticipated Investment:
With industry input, possibly US 85, I-76 or I-25 Co Springs-Ft. Collins, as well as state highways in northern Colorado	Request for Partners issued by end FY 2016	$3 million

COMMUTING

Description: Deploy technology systems and infrastructure systems to improve the reliability of travel times and offer optimized routing and movement of commuters.

Project #1: I-25 Total Managed Motorways Pilot: Implement advanced ramp meters and traffic management systems to facilitate mainline interstate and arterial roadway traffic management.

Geographical Focus:	Timing:	$ Anticipated Investment:
I-25 from RidgeGate to Broadway in metro Denver	RFP by end FY 2016	$7 million

SAFETY

Description: Deploy advanced technology systems and infrastructure systems to improve the safety of Colorado roadways.

Project #1: Rural Road Safety Pilot: Transform a rural State Highway into the safest corridor in the state with goal of zero deaths using technologies such as connected vehicles, smart infrastructure (virtual guardrails, smart lane markings, etc.)

Geographical Focus:	Timing:	$ Anticipated Investment:
Southeast and southwest Colorado	Request for Partners by end of FY 2016	$3 million

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Project #2: Striping Improvements
Description: The reflectivity and durability of roadway pavement markings will allow vehicles that use these marking for guidance and lane designations to be utilized on more roads in Colorado. Additionally, an immediate benefit can be realized for the traveling public today.

📍 Geographical Focus:	📅 Timing:	💲 Anticipated Investment:
Major Corridors Statewide	2016 and Beyond	$3 million to $5 million above already-programmed funds

INTEGRATION

Description (Planning): Enable a planning framework that ensures technology and operational innovations are embedded into the overall transportation planning framework.

Project #1: Technology Planning Process: Develop NEPA/environmental evaluation process that effectively includes technology and operation innovations as a significant part of the alternatives analysis. For projects already past the environmental evaluation process, develop a "RoadX" clearance process to ensure all alternatives are incorporated as a project moved into design.

📍 Geographical Focus:	📅 Timing:	💲 Anticipated Investment:
Statewide	Issue RFP for consultant support by end FY 2016	$1 million

Description (People): Ensure that CDOT has the human capital and resources to understand and effectively integrate innovative technologies while transforming how the department "does business."

Project #1: Workforce of the Future Analysis: Conduct scenario planning to prepare for the types of employees and skills that will be necessary to implement RoadX in addition to other future roles.

📍 Geographical Focus:	📅 Timing:	💲 Anticipated Investment:
Statewide	RFP has been issued	$2 million

Project #2: Engineering Training Program: Develop a nation-leading, comprehensive Engineering in Training program that includes a two-year rotation in several necessary skill sets including: technology/operations, planning, communications, economic development, engineering (materials, bridges, roads, assets), maintenance, project management, cash management, contracts. Goal is to recruit nation-wide to train the best and brightest.

📍 Geographical Focus:	📅 Timing:	💲 Anticipated Investment:
Statewide	RFP for consultant support by end FY 2016	$1 million

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